Chapter 12
Growing 'The Wood of The Gods': Agarwood Production in Southeast Asia

G.A. Persoon*

Abstract Agarwood, also known as eaglewood or *gaharu*, is a valuable non-timber forest product which sometimes grows in *Aquilaria* species. The genus species occur mainly in South and Southeast Asia. As a result of a defense mechanism to fend off pathogenes, *Aquilaria* species develop agarwood which can be used for incense, perfume, and traditional medicines. The main markets for these products are in South and East Asia and the Middle East.

The high prices demanded for agarwood has led to the rapid depletion of *Aquilaria* trees in natural forests. The search for agarwood has spread from one country to another. At present Indonesia and Papua New Guinea are the main supplies. Because of the rapid depletion of the agarwood in the wild, the species was put on the CITES Appendix II as endangered.

Efforts have been undertaken to increase the production of the infected wood by deliberately wounding the trees. A variety of methods is used towards this end. Some recently developed techniques have proven to be most effective. This resulted in planting of *Aquilaria* trees by small holders as well as large industrial size plantations.

In this chapter we shall discuss a particular agarwood project in Vietnam and some other locations elsewhere promoting growing of *Aquilaria* trees among small holders. The general approach of the project to stimulate the growing of the trees among local communities will be discussed against the background of the international demand for this highly valuable non-timber forest product. Finally some potential developments of the future will be described.

Keywords Domestication, future developments, plantations, Vietnam, wild harvesting

Institute of Environmental Sciences, Leiden University, P.O. Box 9518, 2300 RA, Leiden, The Netherlands

***Corresponding author:** persoon@cml.leidenuniv.nl

D.J. Snelder and R.D. Lasco (eds.), *Smallholder Tree Growing for Rural Development and Environmental Services.*

12.1 Introduction

In the intellectual discourse about deforestation, there is, since about two decades, a strong plea for attention to the economic and social relevance of non-timber forests products. It is argued that the sustainable exploitation of products like rattan, bush meat, honey, medicinal plants and numerous other products, provides a viable alternative to the rapid and large scale commercial logging. This discussion was largely stimulated by two provocative publications both published the same year (Peters et al. 1989; De Beer and McDermott 1989). It is also argued that forests might include a large number of potentially relevant plants and animals which are undiscovered for their use in pharmaceutical and other products. Even though their economic value might be difficult to calculate at this moment, numerous scientists remind us that the economic potential of these resources should not be overlooked. Even more difficult to value is the wealth of in-tact forest areas in terms of non-utilitarian biological diversity and environmental services (Kusters and Belcher 2004).

Local populations depend to a large extent on non-timber forest products for their food, medicine as well as cash income. For that reason socio-economic as well as the cultural value of forest areas and biodiversity should not be neglected in the economic appraisal of forest resources (Posey 1999).

Though this debate has generated a large body of interesting and sophisticated science, it has contributed relatively little knowledge that persuaded decision makers to slow down the process of forest degradation in many tropical rainforest areas (Dove 1993; Ros-Tonen 1999). In addition there is another interesting aspect to be considered in relation to the economic value of non-timber forest products which is related to the process of domestication of these products by small holders, and which has implicitly undermined the potential value of forest areas. Through manipulation, or domestication of the reproductive process of certain plants and animals, the harvest of such products can be increased and can generate additional income for the local communities (Wiersum 1999). Many development projects are based on this pre-conception. However, in case income is really substantial or market opportunities are really attractive, new groups of people might get involved in the production of such products and transfer the production of such plants and animal or animal products to other locations. In this process the real or potential value of the forest resources are removed from their place of origin and moved to new localities. The forest dwelling communities find themselves in an unequal competition with these external producers. In other words, both economic and social value is being removed from forest areas. This process seems to follow the logic of market forces (supply driven by demand) and little in terms of protection of rights to genetic resources or intellectual property held by the forest dwelling small holders. International conventions like the Convention on Biological Diversity which also aims at the equitable access and benefit sharing of benefits from genetic resources have not been able to provide sufficient guarantees for forest dwelling communities.

In this chapter we want to discuss the economic importance of a particular non-timber forest product, agarwood, that is harvested from the wild in the lowland forests of Southeast Asia but is increasingly being produced in a domesticated way. This domestication denies forest dwelling communities economic opportunities, and real and potential value from the forest.

Agarwood is without doubt one of the most fascinating non-timber forest products in the world. It is the infected wood of the *Aquilaria* and *Gyrinops* species. Agarwood is often called 'the Wood of the Gods' because of its use as incense for religious ceremonies. Agarwood is in high demand in many countries and cultures. As incense it is a product with an almost universal religious function as incense is used to symbolize purification and to accompany sacrifices and prayers from earth to heaven. Incense has pervaded religious history and agarwood incense is by far the most expensive type of incense. It has been in use since ancient times. Egyptians and Greeks are known to have used it for death rituals. But does this special religious function imply a special treatment of the tree in terms of production or processing? Does it lead to special protective measures? And does the agarwood producing tree enjoy a status as a 'sacred plant' or can it be used as an example of a religiously inspired example of environmental care?

12.2 The World of Agarwood

Buddhist monks, Arabic perfumers, Japanese incense producers, Thai farmers and Papuan collectors were just some of the cast at the 2nd International Agarwood Conference (March 2007, Bangkok). Participants came from more than thirty countries. The 'world of science' was represented by wood pathologists, anthropologists, foresters, economists and laboratory analysts each with their specific research interests. Alongside the scientists were entrepreneurs from Australia, potential investors in the opportunities that *Aquilaria* plantations might offer. Finally there were nature conservationists concerned with the survival of the tree species as agarwood features on the CITES appendix II list. In total more than 120 people – covering the full agarwood spectrum from production to consumption – came together to discuss the future life of the infected wood of a wounded tree.

Over a period of one week they were all discussing the results of their research and experiences. Visits to plantations, distillation factories and agarwood trading companies completed the programme. Throughout the week there were fascinating comparisons between the results of the laboratory experiments and the judgments of traders who still rely heavily on the 'naked eye and nose' for determining the grading the quality of agarwood. This stood in sharp contrast with the state of the art scientific discovery in the fields of microbiology, bioreactor analysis and DNA fingerprinting. Besides the plenary sessions, there were also discussions in small circles about business secrets with respect to the best sources of agarwood, the art of perfume design and incense making and the continuing illegal trade.

12.3 Agarwood: Its History and Its Uses

Agarwood is resin impregnated wood produced by a number of *Aquilaria* and *Gyrinops* species (Thymelaeaceae). There are 25 different species found in Southeast Asia. Not all species are found in all Southeast Asian countries. The most important species are *Aquilaria malaccensis*, *Aquilaria crassna*, *Aquilaria sinensis*, *Aquilaria rugosa* (Santisuk 2007). The trees occur from near sea level altitude up to about 1,500 m above sea level (depending on species). It is a large evergreen tree that can reach a height of over 30 m and a maximum diameter of over 1 m. Indonesia, Malaysia, Cambodia, Lao DPR and Papua New Guinea are the main present day producing countries. Recent research is adding new species to the list of agarwood producing trees, like *Gyrinops ledermannii* in Papua New Guinea (Compton and Zich 2002), and *Aquilaria rugosa* (Kiet et al. 2005). The resin-impregnated wood is fragrant and, highly valuable as it is rare and in short supply. This resin is formed as a result of pathological processes. It is also thought that resin production is a response to fungal infection. Interestingly however, not all *Aquilaria* trees produce resin and it is difficult for the inexperienced to judge if a tree holds agarwood. Cutting the tree down is the only way for many to find out whether the tree contains agarwood.

Use of agarwood has been reported in many ancient cultures, even though the history of agarwood use has still to be written. The Egyptians are believed to have used agarwood incense as part of their death rituals more than 3,000 years ago. It is also suggested that incense trade was in fact the first international trade route that existed in history. In Japan, agarwood is said to have arrived with Buddhism. In Vietnam ancient texts also refer to the use of agarwood in relation to traveling Buddhist monks. In the colonial literature in Southeast Asia (Indonesia and Malaysia, agarwood is often mentioned as a very important non-timber forest product (see for instance: Schuitemaker 1933; Dunn 1982).

Today the range of agarwood products and their uses is seemingly endless. Solid pieces of agarwood are highly appreciated as ‘natural art’ in Japan, Korea and Taiwan. Craftsmen carve raw pieces of agarwood into beautiful wooden sculptures. Agarwood is also turned into beads and bracelets. Most of the wood, however, is processed and either turned into oil which is used in perfumes and other cosmetic products, or the agarwood chips are ground into powder which is used as the raw material for incense making. Thin sticks are used to insert into cigarettes in for example Taiwan. Powder is also used in the production of traditional Chinese and Korean medicine, and for the preparation of (medicinal) wine and various other products.

The oil is mainly used in the Arab world where it is in high demand. It is by far the most precious of essential oils with prices reaching as much as ten times that of sandalwood oil (obtained from *Santalum album* and *Santalum spicatum*). The largest market for top class incense is Japan with its long tradition in incense making. Both the Arab countries and Japan are interested in high quality agarwood and manufacturers in these countries prefer to process the raw material themselves. This also avoids the mixing of high grade agarwood with wood of lower quality.

The oil is extracted from the agarwood through distillation. This delicate process determines both the amount and quality of oil produced. The wood is ground into very small pieces and/or powder, which are immersed in water and left to soak. Then the material is transferred to kettles and distilled. After heating, the condensed water and oil are captured in a container where the oil is separated and floats on top of the water. The water is removed and the oil is thus recovered. The price of high quality oil can be as much as US$30,000–US$50,000 per litre. This process can be repeated once or twice depending on the quality of the water and the costs of the distillation process. The powder which remains after distillation can be used for low grade incense making. It is estimated that for the production of one liter of oil up to 150 kg of agarwood is needed.

The most important use of agarwood is without doubt incense for religious purposes. Incense is used in a wide variety of religions. In fact incense plays an important role in almost all religions, because of its pleasant smell, its smoke rising to heaven, its purifying nature because of its relation fire and various other reasons. Some of the symbolic functions of incense that are mentioned in the literature about its religious use are the following:

1. Homage to God, the Gods or the ancestors and other spirits
2. Zeal of faithful to be animated
3. To accompany the prayers rising to heaven
4. To accompany the sacrifices made to heaven
5. In relation to death rituals, the safe passage of a deceased person to the after life
6. Cleaning/preparation of religious icons, altars and the religious officials (Groom 1981; Hoskin 1994; Catholic Encyclopedia 1998; Sinha 2005)

In comparison with the attention paid to the use and importance of incense in religious symbolism, it is surprising to notice how little attention is actually paid to the incense producing plants, including the *Aquilaria* trees. Other plants producing incense ingredients are frankincense (*Boswellia Thurifera*), sandalwood (*Santalum album* and *Santalum spicatum*), benzoin (*Styrax benzoin*), camphor (*Cinnamomum camphora*), and patchouli (*Pogostemon heyanus*). Little if anything is written in these publications on the production itself, the people involved in its harvesting or the status of the trees. Incense materials are in most cases obtained through complex trading networks involving collecting traders operating in the frontier of harvesting areas, wholesale dealers and distributors. Quality and price are the dominating factors involved, but giving the nature of the product it is evident that trust between sellers and buyers is of utmost importance. Only a small proportion of the agarwood users do harvest or grow agarwood themselves. Some Buddhist monasteries in Vietnam, Lao DPR and Thailand have agarwood trees planted in their gardens to supply their limited needs. In other cases supply is obtained through trade networks based on economic principles.

All actors involved in the agarwood business acknowledge that a large part of the trade takes place illegally. The CITES requirements are often not fulfilled. Sustainability of agarwood production does not seem to be a major concern for most traders and end users. As yet there is no certification system for agarwood comparable for instance with a Forest Stewardship Council (FSC) certificate for sustainably produced timber.

12.4 Wild and Cultivated Agarwood

For centuries agarwood has been harvested from natural forests. Usually *Aquilaria* or *Gyrinops* trees were cut and people looked for infected wood inside the stem of the tree. Highest quality agarwood can fetch as much as US$1,000 per kilograms. The agarwood trade has been connected to an ever moving frontier across the forest of Southeast Asia. Traders were continuously searching for untouched forests with stands of *Aquilaria* trees. The trees were fetching high prices and as a result, the news about agarwood harvesting spread like 'gold fever' among forest dwelling communities. Large sums of money and all kinds of luxury items were offered to the forest inhabitants in exchange for agarwood. In recent times this kind of 'agarwood fever' has spread in a similar fashion into the forests of East Kalimantan, Papua New Guinea, and Lao DPR. Interesting case studies have been written on this moving frontier of agarwood harvesting and their effects on the economy of the local, forest dwelling communities (see for instance Momberg et al. 2000; Wollenberg 2001, 2003; Zich and Compton 2001; NTFP Programme 2006). Usually this 'fever' was

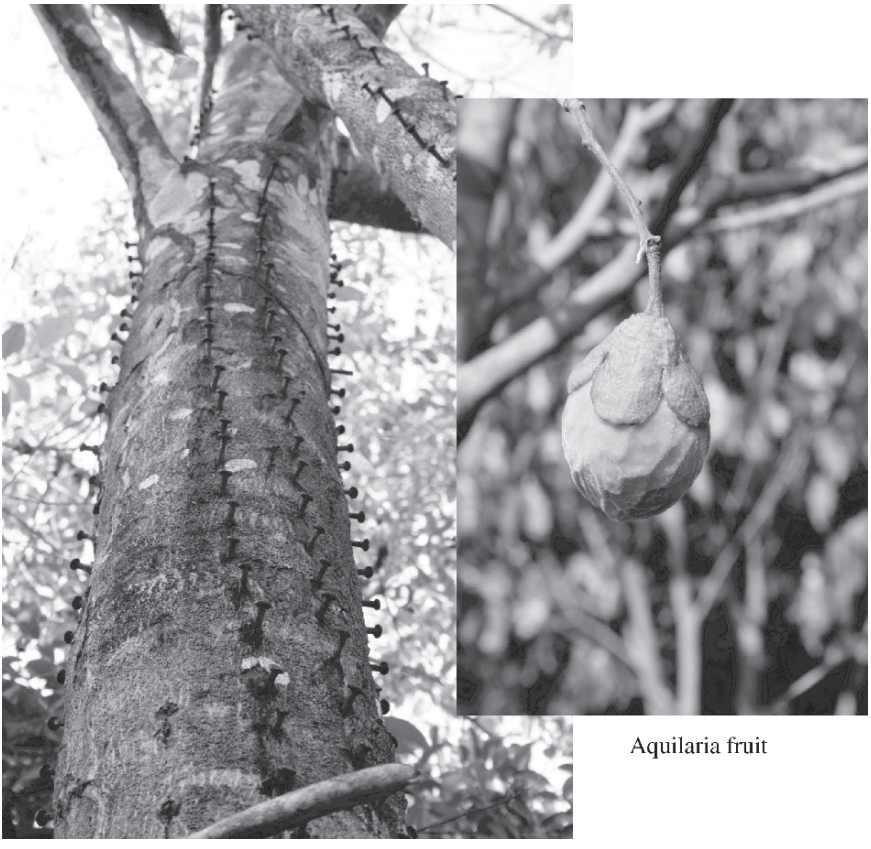

Photo 12.1 The application of nails to Aquilaria trees to agarwood growth (©GA Persoon)

only temporary. Once the largest trees were cut, new harvesting expeditions became less successful and just as in the case of gold, the collecting of small quantities of agarwood became a less rewarding activity. This method of harvesting however has lead to overexploitation of the resource, far beyond the reproductive ecology of the *Aquilaria* trees (Soehartono and Newton 2001).

The high prices for agarwood and the local depletion of resources in the wild have led to a variety of efforts to stimulate the growth of agarwood. Farmers started to integrate *Aquilaria* trees into their home gardens as these trees can easily be intercropped with other home garden tree species. Moreover the agarwood trees need little care during the first few years. The trees have to grow first before the agarwood formation can actually be started. These small holders use a variety of simple wounding techniques to start this process. Farmers in countries such as Vietnam, Lao DPR, Indonesia and India have gained some experience in the production of low grade agarwood. Axe wounds, severe bark removal, nailing and other types of wounding are being applied. These methods only yield small amounts of low quality resin for a limited period and due to their low yield, these methods may also lead to the destruction of trees. The most common method is the deliberate wounding of trees with large knives or the hammering of nails into tree trunks. The agarwood produced in this way is of inferior quality and can only used for home consumption, and low quality agarwood. Moreover high quality agarwood takes many years to develop and not many small holders are willing to wait that long.

12.5 Planting *Aquilaria* Trees for Agarwood Production

It is only during the last few decades that a more scientific approach has been developed to stimulate the cultivation of agarwood through artificial wounding of the trees. Planting *Aquilaria* trees has become a common practice now at numerous localities. In particular people who used to be gatherers of wild agarwood have started to grow *Aquilaria* trees in their home gardens or in their forest fields experimenting with all kinds of wounding techniques. More scientific experiments were set up by forest research institutions in several countries including China, India, Thailand, Vietnam, Bhutan, and Indonesia. In Indonesia for instance plantations are established in East Kalimantan, Lombok, Sumba and Papua. In some of these areas relatively large scale plantations are established with thousands of *Aquilaria* trees and substantial investments in processing units. In some cases these plantations developed out of small holder initiatives while in others enterprising individuals with business interests were attracted to the potentially high profits that can be made in agarwood production.

12.5.1 Agarwood Cultivation in Vietnam

One of the most successful efforts to date has been a project initiated in Vietnam. Several independent research initiatives were started in the middle and late nineties in Vietnam. One of these initiatives was The Rainforest Project Foundation's (TRP)

Agarwood Project which was partially funded by the European Commission. TRP started in 1993 in An Giang and Phu Quoc Island, two of the three last remaining areas with highly endangered and isolated *Aquilaria crassna* populations in the Mekong Delta. The third *Aquilaria* growing area in the Mekong delta is situated around Ha Tien City on the border of Cambodia and the gulf of Thailand, in Kien Giang province.

In An Giang *Aquilaria crassna* was still growing in the early 1990's as the result of natural propagation around a dwindling number of large mother trees. In 1993 only 13 larger, over 20 year old seed producing trees remained, with several hundreds of smaller trees providing regeneration. One plantation of around 50 trees had been established several years earlier. Phu Quoc still contained about 30,000 ha of disturbed, but viable lowland tropical forest at the time with some *Aquilaria* trees remaining. The Forestry Service of Kien Giang had planted about half a hectare in the early 1990s. All in all the entire *Aquilaria crassna* population in the early 1990s in the Mekong delta consisted of just a few thousand genetically closely related *Aquilaria crassna* trees. Today, at least half a million trees are growing in the delta in home gardens and plantations.

Photo 12.2 Preparation of Agarwood (Aquilaria crassna) seedlings in An Giang, Vietnam (©GA Persoon)

In addition to laboratory analysis, field experiments were developed. Local inhabitants in the An Giang Seven Mountain Area, including the Buddhist monks, had used various simple wounding techniques for generations. They had used the agarwood for personal and religious reasons for a very long period already. In the Central Highlands of the country nails were applied to *Aquilaria* trees to induce agarwood growth.

The experiments were undertaken with local farmers and provincial authorities. Building on their knowledge, experimental plots were developed to stimulate the production of agarwood. The new technology to cultivate agarwood in plantations was developed by a team of scientists at the University of Minnesota in the United States (UMN) led by Professor Robert Blanchette and Henry Heuveling van Beek of The Rainforest Project.

The Seven Mountain Area was a logical start for the project because of the familiarity of the farmers with small scale agarwood production. Some farmers had already started their small scale plantation even before the project had entered the area. This area had suffered heavily from the invasion of the Khmer Rouges guerilla before 1978. During that period thousands of *Aquilaria* trees were chopped down. The political unrest and the resettlement of the inhabitants in the decades that followed also negatively influenced the number of *Aquilaira* trees in this mountainous borderland with Cambodia. Once the situation slowly returned back to normal again, the monks and local people were faced with a shortage of agarwood for their ritual and traditional purposes. That is why the initial response to the idea to promote the growth of *Aquilaria* trees was very positive. At the start of the project, when it was proposed to initiate agarwood production on a larger scale, farmers pointed to the lack of income during an estimated five to seven year inception period. After that period farmers could start selling the first agarwood while replanting would also take place at the same time. In order to stimulate the planting of *Aquilaria* seedlings these were provided to farmers at no costs. During the first few years of the project the farmers would receive a payment for their investments on condition that they share the profit after harvesting. Four years after the start of the project, and that was still before the first harvesting took place, about 25,000 *Aquilaria* seedlings were planted in the Seven Mountain Area (TRP 1999).

In the years that followed numerous technical experiments were done in order to determine the optimal formation of agarwood. The experiments included the drilling of holes in the trees and the insertion of different combinations of chemicals and many different naturally occurring fungi into trees of varying age or size, density and degree of intercropping. A chemical treatment was added to the wound to encourage the trees defense mechanism which stimulates the production of the resin. After years of experimenting, the first trees were recently harvested and the production of incense made from the cultivated agarwood has begun. The success of the experiment means it will not be long before the technology spreads to other areas where *Aquilaria* trees are being grown.

Chemical analyses were conducted of the cultivated agarwood and these were compared with the chemical composition of agarwood harvested from forests. In the initial phase relatively good agarwood was produced after two years of wounding and treatment but based on continuous evaluation and improvement of the

technology, this time frame has now been shortened to 15 to 18 months. The agarwood produced in this way turns out to be suitable for the production of incense sticks and medium grade oil (Eurlings and Gravendeel 2005, 2007).

In the past 10 years agarwood tree plantations really began to take off with an enormous boost in planting in the last few years. This was driven by the higher pricing caused by lack of supplies of forest based agarwood, and the successful inducement technology, fueled by hope and rumors as well as by serious concerted research efforts.

As stated above agarwood is the woody part of *Aquilaria* and *Gyrinops* trees containing resin. Agarwood only rarely and infrequently occurs in those tree species naturally. Wounding trees triggers resin formation. This resin in *Aquilaria* or *Gyrinops* trees forms very slowly and fills areas around the wound(s) to fend off pathogens such as bacteria and fungi.

A first generation of domestication processes was developed in 1996–1997, using drill wounds and a variety of biological agents such as fungi. However, while superior to previously known inducement methods, UMN/TRP research and hundreds of field tests showed limited amounts of resin formation and inconsistent results with this early technology.

In contrast, consistent results are obtained when the second generation advanced inducement technology is applied: holes are drilled into the tree in a particular pattern, a special mix of chemicals is inserted, and special PVC tubes are inserted and

Photo 12.3 Demonstration of Agarwood harvesting in An Giang, Vietnam (©GA Persoon)

remain in the tree for the rest of its life. Complete installation takes about 20–30 minutes per tree. TRP has designed agarwood inducement kits, which are now available in Thailand, Lao PDR Vietnam, and by 2008 in Malaysia and Bangladesh. The application varies according to tree size and the diameter at breast height (DBH). Kits will be provided in standard packages to treat different sizes of trees.

A third generation is now developed with a special re-treatment, which can be applied after 12 months to maximize resin formation. Harvesting can be initiated six to 12 months after the second treatment. Trees, which are allowed to grow longer, will produce higher quality agarwood.

TRP technology uses the entire tree to form agarwood; it is the least labor intensive and the highest yielding method for producing agarwood. Comparing TRP Cultivated Agarwood technologies:

Simple inducement (wounding)	First generation CA technology	2nd and 3rd generation CA technology
Only low yields	Low-medium yields	Highest possible yields
Commercially not viable	Commercially hardly viable	Commercially viable
Low cost/low return	Medium cost/low return	Medium cost/high return
I.P.R. acquired or pending	I.P.R. acquired or pending	I.P.R. acquired or pending
Low labor intensity	Medium labor intensive	Low labor intensive
Simple application	Complicated technology	Uncomplicated technology
Technology free	High costs to manufacture	Medium cost manufacture
Training simple	Training easy	Training easy
Slow	Duration 12–36 months	Duration 12–36 months
Not certified	Will be certified	Certified
Now applied	Applied small scale	Applied in trials
Scientifically tested	Scientifically tested	Scientifically tested

In the Seven Mountain Area hundreds of farmers have established their plantations in combination with the cultivation of other tree or food crops. Production of commercial agarwood has started. Incense is produced in the area and sold under the name of Scented Mountain *Cultivated Agarwood*. The quality is relatively good and is rapidly increasing.

12.5.2 Agarwood Production in Thailand

Thailand has been a traditional producer and consumer of relatively large amounts of agarwood. Over the years trade in the wide variety of agarwood products has developed in Bangkok. Large amounts of agarwood products not only from the country itself but also from neighbouring Cambodia and Lao DPR is channeled through the city to markets in East Asia as well as in the Arab world.

The declining supply has lead Thai scientists in combination with the private sector to set up some relatively large scale plantations. One of these plantations is run by a company called Krissana Panasin in Chantaburi in Southeast Thailand. Over the years it has established a substantial plantation of several hundred hectares, including nurseries and processing and distillation units. The research department

of the company has been experimenting with all kinds of techniques to obtain the optimal quality of agarwood. There is a close cooperation with a number of scientists in the country. Moreover it provides seedlings to interested farmers who can produce agarwood trees on their own farm lots. The company has also been instrumental is the establishment of an organization called the Thailand Agarwood Grower Society to assist and train farmers, as small holder tree growers, in the cultivation of agarwood. It is a non-profit organization aimed to transfer knowledge on the whole process of producing agarwood in an effort to reach the quality standards of the Middle East.

The technology to wound the trees in order to start agarwood production is also provided to the small holder farmers by the company. In due time the trees are being sold for processing to the company as the farmers usually lack the connections and skills to organize the transport or processing to other buyers outside the area.

The company is not only involved it the cultivation of agarwood it also has started the production of a range of end products for which an extensive public relation department was established in order to reach whole sale traders in consumer countries directly. In this way it tries to by-pass the intermediate traders at least within Thailand but also in places like Singapore or Hong Kong which mainly serve as import and re-export sites.

12.5.3 Agarwood Production in Indonesia

All over Indonesia, in areas that used to produce agarwood harvested from the wild, local people have started experimenting in cultivating agarwood using a wide variety of techniques. In some cases forestry research departments of local universities are involved in the experiments as agarwood is considered one of the most valuable non-timber forest products with a good potential for forestry-based incomes. In East Kalimantan for instance forest scientists of Mulawarman University in Samarinda in cooperation with the research institute of the Forestry Department are involved in research on agarwood producing techniques to assist local farmers in finding new livelihood alternatives now the harvesting of wild agarwood is rapidly decreasing. Large scale logging sometimes followed by complete conversion into other form of land use like oil palm plantations or transmigration sites have led to an enormous reduction of ‘wild forest’ from which agarwood could still be harvested. In the efforts to promote agroforestry and in particular the production of NTFP’s agarwood is one of the main products. In addition research activities are undertaken for the production of other NTFP’s like rattan, *gemor* (tree bark used for the production of mosquito repellant), honey and birds’ nets (certain species of swallows) (Yusliansyah and Kholik 2003; Siran 2006).

Another area within Indonesia where agarwood plantations are being established at the moment is in the districts of Assue and Mappi in Southeast Papua. It is an area in which harvesting from the wild is largely a thing of the past. The agarwood ‘fever’ developed in this district since around 1995 but, just like in so many other areas,

within a relatively short time the harvest was over and took place without any form of control. It did not only involve the local population but it attracted also large numbers of migrants invading indigenous territories. All major stands of agarwood trees have been exploited. In a kind of second or even third harvest people even dig up roots of trees in the swamps which might still contain some agarwood.

At the same time however a church based organization (Roman Catholic) has initiated a project to start the cultivation of agarwood. The project consists of three elements: the cultivation of *Aquilaria* trees, the technique of inoculation and the practice of harvesting. The main purpose of the project is to help the people in gaining a more sustainable form of livelihood. Nurseries are set up using seeds from a number of mature *Aquilaria* trees. The seedlings are being planted in combination with other annual or perennial crops. The cultivation fits nicely with other agroforestry practices promoting the planting of crops like rubber, dammar, sago, cashew and a wide range of other trees.

The process of inoculation can only be done when the trees have reached a minimal diameter. It is assumed that trees should be at least 10 cm in diameter and at least five or six years old before they can be treated. Holes are drilled and a fungus is placed in them. It is assumed that harvesting should not take place before one year after the inoculation of the tree, but the longer the harvest is postponed the more agarwood the tree will contain. Harvesting in itself is probably the most difficult aspect of the cultivation process, determining very much the quality of the agarwood chips and thereby the price of the product. One needs to carve out the infected wood carefully. The project is assisted by a scientist from the Mataram University on the island of Lombok who has gained some training and experience abroad. As yet there are no processing or distillation units available in the area. The chips are being sold to intermediate traders who eventually will trade the agarwood to Singapore.

At present some 400 farmers are involved in this project, each having planted twenty or more seedlings in their home gardens and agroforestry plots. It is hoped that the investment in agarwood seedlings, land preparation, tree care, inoculation and final harvesting will bear fruit in the near future. Whether this will in the long run also lead to some activities in the field of agarwood processing is not yet clear. It will require additional expertise and investments while in the end it is still the agarwood trader who determines the price of the product in whatever form it is offered to him (Ogi 2007).

12.6 Protection

As a result of serious overexploitation of agarwood from the wild, a number of measures to protect the *Aquilaria* trees, and thus ensure the survival of the trees in the lowland forest of Southeast Asia, have been taken. Production of cultivated agarwood seems to be a logical way out of this problem. Cultivated agarwood could simply replace the 'wild' agarwood. However, some representatives of conservation organizations point to an apparent lexical confusion as one of the main obstacles in

this thorny trade domain. For some years the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has listed all *Aquilaria* species in its Appendix II. This implies the need to monitor the trade (both import and export) (Newton and Soehartono 2001). However, because agarwood is known across the world by many different names (such as eaglewood, aloeswood, *jinko*, *gaharu*, and *oudh*), and because it is used or even disguised in so many different products (such as oil, perfumes, incense, wine, wood dust and chips), tracking agarwood products requires highly sophisticated detection procedures which are not yet in place in most countries. This is one of the reasons why the illegal trade in agarwood cannot easily be stopped. One of the challenges ahead will be the differentiation between wild and cultivated agarwood. Without doubt some of these issues will be discussed during the next agarwood conference which will take place in a few years time. During the recently held Conference of Parties to the CITES convention (The Hague, 2–15 June, 2007) proposals were submitted through the plants commission to differentiate between the wild and cultivated agarwood products, in a way similar to many other products (like for instance crocodile skins). In this way export and import of cultivated agarwood products would become less troublesome. However these proposals were not adopted by the parties because of the lack of effective implementation methods.

12.7 Conclusion

It may come as a surprise to some that the chain of production to consumption of agarwood, does not enjoy any special position along the way until its final destination. It seems that it is only once agarwood has been turned into incense that it obtains a special status as a product to be used in rituals with a symbolic meaning. Until that moment it is devoid of any special relevance. It is just another object of trade and profit making even though the trade itself is highly specialized and requires substantial skills in terms of smelling, grading the quality and processing. The history of exploitation of agarwood producing trees does not seem to be any different from any other equally high valued but non-religious product. Resource extraction through an ever moving frontier leading to over-exploitation dominates its history. It is highly unlikely that this will change in the future in spite of some prevailing ideas to look for religiously inspired caring for the environment (Palmer and Finlay 2003).

The rapidly diminishing agarwood harvests from the wild have stimulated the production of agarwood through active tree planting and treatment by small holders throughout South and Southeast Asia. Initially the people involved in this domestication process were the same as those involved in the harvesting from the wild. But as domesticated agarwood is likely to become more important and more productive it also attracts the attention of potential investors from a number of countries. Plantations are already established in Thailand, India, Indonesia, Vietnam, Bangladesh, Lao PDR, Cambodia, Malaysia and others (small scale but also in Bhutan, China, Burma, etc.) Absolutely new on the scene are the business people

from Australia and the United States. Having gained substantial experience in the production of sandalwood in Western Australia, some companies are now ready to turn their efforts to *Aquilaria* plantations which potentially could yield even higher prices per production or investment unit (Coakley 2007). These companies also have the possibility to plan for a more distant future than many small holder tree growers who, because of a shortage of resources to invest, require quicker returns for their investments. Harvesting at an earlier stage and thereby of lower quality will therefore be the result (see Fig. 12.1).

In the meantime, and as is the case with many other expensive products, there is an influx of fake agarwood products into the market. Some of these products go by the name of Black Magic Wood (BMW), and in fact are made from *Aquilaria* wood which has been impregnated with cheap artificial oil. It requires a trained eye and nose to differentiate real agarwood from these fake products however there is a ready market for this product, which however is often sold as genuine agarwood (in Malaysia, Thailand and middle eastern countries).

There are of course a number of questions to be asked in relation to the large scale domesticated production of agarwood: Can the high prices currently paid for agarwood be sustained if production is substantially increased? What will the quality of the cultivated product be? There are also concerns about the consequences of large-scale cultivation for the traditional producers of agarwood, the collectors inside the forested areas. It is generally assumed that the natural top quality agarwood will become rare but remain in demand, particularly in Japan. This 'top end' of the market cannot easily be replaced by cultivated agarwood. At the mid and lower level of the agarwood supply, it is predicted that there will be an increase in supply from the new areas. In the foreseeable future prices will remain high. However, a slow and gradual reduction in price is expected when large supplies enter the market in about 10 years as a result of this increased cultivation. Finally it is assumed that the production, and therefore the value, will gradually move from the original rainforest areas to plantations located in other areas. There are also other cases of non-timber forest products in the tropics of which the centres of production have been transferred to other areas. Rattan, orchids and various types of bush meat or animal skins

Type of activity	Producers
Harvesting from wild *Aquilaria* stands	Traditional forest dwellers
Harvesting from wild stands and deliberate wounding of trees	Forest dwellers and commercial collectors
Cultivating of wild trees and deliberate wounding	Forest dwellers and commercial collectors
Production of domestication trees, small plantations and new wounding techniques	Forest-based farmers, and neigh bouring communities
Larger plantations and research based wounding and inoculation techniques	Local and national forest-based industries
Large industrial plantations at new (and distant) locations	Foreign forest-based enterprises

Fig 12.1 Stages in agarwood production

were originally products harvested from the wild by the forest dwelling communities earning a substantial part of their income by the hunting and gathering activities. However in all these cases new actors entered the scene, once domestication of the plant and animal species turned out to be a profitable business. In many cases and depending on the amount of technology and specialized labour involved, the productive units were transferred to other and often distant locations. People originally involved in the domestication process were not recruited anymore once sufficient seedlings or breeding animals were collected. Rattan and orchid gardens, crocodile and deer farms are just some of these examples. It is likely that a similar development might also take place in the future with respect to the production of agarwood. Most likely the forest based people will continue to harvest until collecting agarwood will no longer be rewarding. The technology involved in the artificial production of high grade agarwood and the need for technically high level processing units can not easily be organized by local producers. The more sophisticated producers, with more financial and technological means at their disposal can simply out-compete the local ones. In this process market forces and business opportunities are likely to completely dominate this development. Traditional growers of agarwood such as those in Vietnam and Thailand will easily be out-competed and become only the providers of the local demand for agarwood. They can only maintain a special position if a kind of differentiation in the market will actually take place for instance on the basis of the production methods or the area of origin. This may allow for an appreciation of the way agarwood is produced (e.g. by monks), or a positive appreciation for the locality where *Aquilaira* trees are grown. Differentiation based on certification of agarwood referring to its geographical origin, traditional methods of production, aspects of 'fair trade' or 'ethical shopping' in particular for an item that is used for religious purposes, might provide some relative advantage for small holder agarwood farmers. As yet however this differentiation is not yet in place. This fact indicates that the small holder agarwood farmers may be facing severe competition from large scale agarwood producers in other parts of the world. If the consumers of whatever kind of agarwood products are willing to include aspects like 'tradition', 'religiosity', 'original or indigenous producers', or 'fair benefits' in their considerations when buying agarwood products, then small holder agarwood farmers might have a chance to survive as suppliers of the 'wood of the gods'.

References

Barden A, Awang Anak N, Mulliken T and Song M (2000) Heart of the matter. Agarwood use and trade and CITES implementation for Aquilaria Malaccensis. Cambridge, TRAFFIC

Catholic Encyclopedia (1998) Incense. Available at http://www.ewtn.com/library/ HOMELIBR/ CEINCENS.TXT accessed on 14 November 2007

Chhetri DB, Pelden K and Dhendup K (2004) Sustainable agarwood production through artificial inducement in Bhutan. Council of RNR Research of Bhutan

Coakley T (2007) Similarities of agarwood and sandalwood. Paper presented at the Second International Agarwood Conference, Bangkok/Chantaburi/Koh Chang, 4–11 March

Compton JGS and Zich FA (2002) Gyrinoips ledermannii (Thymelaeaceae), being an agarwood producing species prompts call for further examination of taxonomic implications in the generic delimination between Aquilaria and gyrinops. Flora Malesiana Bulletin 13(1): 61–65

De Beer J and McDermott M (1989) The economic value of non-timber forest products in Southeast Asia. Amsterdam, IUCN Netherlands

Dove MR (1993) A revisionist view of tropical deforestation and development. Environmental Conservation 20(1): 11–24

Dunn FL (1982) Rain-forest collectors and traders. A study of resource utilization in modern and ancient Malaya. Kuala Lumpur, Royal Asiatic Society

Eurlings M and Gravendeel B (2005) TrnL-trnF sequence data imply paraphyly of Aquilaria and Gyrinops (Thymelaeaceae) and provide new perspectives for agarwood identification. Plant Systematics and Evolution 254(1–2): 1–12

Eurlings M and Gravendeel B (2007) Genotyping agarwood. Paper presented at the Second International Agarwood Conference, Bangkok, March 2007

Groom N (1981) Frankincense and myrrh. A study of the Arabian incense trade. London, Longman

Hansen E (2000) The hidden history of a scented wood: aloeswood. Saudi Aramco World 51(6): 2–13

Hoskin J (1994) Fragrance of the gods. In: Pratt D (ed) Incense. Bangkok, Post Books, pp13–27

Kiet LC, Kessler PJA and Eurlings M (2005) A new species of Aquilaria (Thymelaeaceae) from Vietnam. Blumea 50(1): 135–141

Kusters K and Belcher B (eds) (2004) Forest products, livelihoods and conservation. Case studies of non-timber forest product systems. Vol. 1 – Asia, Bogor, Indonesia, CIFOR

Lawton J (2004) Silk, scents and spice. Paris, UNESCO

Momberg F, Puri R and Jessup T (2000) Exploitation of gaharu, and forest conservation efforts in Kayan Mentarang National park, East Kalimantan, Indonesia. In: Zerner Z (ed) People, plants and justice. The politics of nature conservation. New York, Columbia University Press, pp259–284

Newton AC and Soehartono T (2001) CITES and the conservation of tree species: the case of *Aquilaria* in Indonesia. International Forestry Review 3(1): 27–33

NTFP Exchange Programme (2006) Eaglewood (Video DVD). Manila, NTFP

Ogi, D (2007) Restoration and protection of agarwood (*gaharu*) at district Assue in Mappi recency, Papua, Indonesia. Paper presented at the RNIP workshop, Ba Be (Vietnam), 21–25 August 2007

Palmer M and Finlay V (2003) Faith in conservation. New approaches to religion and the environment. Washington, DC, The World Bank

Peters CM, Gentry AH and Mendelsohn RO (1989) Valuation of an Amazonian forest. Nature 339: 655–656

Posey D (ed) (1999) Cultural and spiritual values of biodiversity. Nairobi, Intermediate Technology Publications

Pratt D (ed) (1994) Incense. Fragrance of the gods. Bangkok, Post Books

Ros-Tonen MAF (1999) NTFP research in the Tropenbos Programme. Results and perspectives. Wageningen, The Tropenbos Foundation

Santisuk T (2007) Taxonomy, geography and ecology of Aquilaria Lamk (*Thymelaeaceae*). In: Continental Asia. Paper presented at the Second International Agarwood Conference, Bangkok, March 2007

Soehartono T and Newton AC (2001) Reproductive ecology of *Aquilaria* spp. In Indonesia. Forest Ecology and Management 152: 59–71

Sinha A (2005) Incense, just blowing smoke! http://zebra.sc.edu/smell/animesh/animesh.html

Siran SA (2006) Ragam hasil hutan bukan kayu dari hutan dipterokarpa. Samarinda, Institute for Research and Forest Development in Kalimantan (Balai Penelitian dan pengembangan kehutanan Kalimantan)

Schuitemaker JP (1933) Het garoehout van West Borneo. Tectona, Boschbouwkundig Tijdschrift 26: 851–892

TRP (The Rainforest Project) (1999) Sustainable Agarwood production in the Vietnamese Rainforests. Final Report for the European Union. Ho Chi Minh City, TRP

TRP (2003) Wood of the Gods. First International Agarwood Conference. The Rain Forest Project, Ho Chi Minh City, 1–15 November

TRP (2007) Second International Agarwood Conference, organised by The Rainforest Project, FOA, TRAFFIC and Kasetsart University (Bangkok). Bangkok/Koh Chang, 4–11 March 2007

Wiersum KF (1999) Social forestry. Changing perspectives in forestry science or practice? Doctoral thesis, Wageningen, Wageningen Agricultural University

Wollenberg EK (2001) Incentives for collecting gaharu (fungal-infected wood of *Aquilaria spp. Thymelaeaceae*) in East Kalimantan. Economic Botany 55(3)

Wollenberg EK (2003) Boundary keeping and access to gaharu among the Kenyah forest users. Environment and Planning A 35: 1007–1023

Yusliansyah and Agus Kholik (2003) Gaharu. Komoditi HHBK andalan Kalimantan Timur. Samarinda, Institute for Research and Forest Development in Kalimantan (Balai Penelitian dan pengembangan kehutanan Kalimantan)

Zich F and Compton J (2001) The final frontier. Towards sustainable management of Papua New Guinea's agarwood resource. Kuala Lumpur, Traffic/WWF